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(71) Applicant: **Central Iron & Steel Research Institute
Beijing 100081 (CN)**

(72) Inventors:

- **YANG, Libin
Beijing 100081 (CN)**

- **WANG, Jie
Beijing 100081 (CN)**
- **YANG, Yong
Beijing 100081 (CN)**
- **ZHAO, Jinxuan
Beijing 100081 (CN)**
- **WANG, Chengyi
Beijing 100081 (CN)**
- **CAI, Wei
Beijing 100081 (CN)**

(74) Representative: **Forresters IP LLP
Skygarden
Erika-Mann-Straße 11
80636 München (DE)**

(54) **ANNULAR-GAP-TYPE GAS SUPPLY ELEMENT, AND GAS SUPPLY METHOD**

(57) The present disclosure discloses an annular-gap-type gas supply element and gas supply method, which belongs to the field of metallurgical technology, and solves the problem that high intensity gas injection cannot be achieved under the condition of thin slag layer, slag-free layer or complex process in the prior art. The annular-gap-type gas supply element includes a central pipe, an inner sleeve, an outer sleeve, an outer gas space and an inner gas space located in the outer gas space, wherein the central pipe, the inner sleeve and the outer sleeve are arranged in turn; at least one inner annular gap is formed between the central pipe and the inner sleeve, and at least one outer annular gap is formed between the inner sleeve and the outer sleeve, wherein the

at least one inner annular gap is connected with the inner gas space, and the at least one outer annular gap is connected with the outer gas space. The gas supply method is that inner gas is injected into metallic bath of a metallurgical furnace through an inner gas space and at least one inner annular gap successively; and/or, outer gas is injected into the metallic bath of the metallurgical furnace through an outer gas space and at least one outer annular gap successively; wherein the types of the inner gas and the outer gas are the same or different. The gas supply element and gas supply method of the present application can be used for high intensity gas injection of metallurgical furnace.

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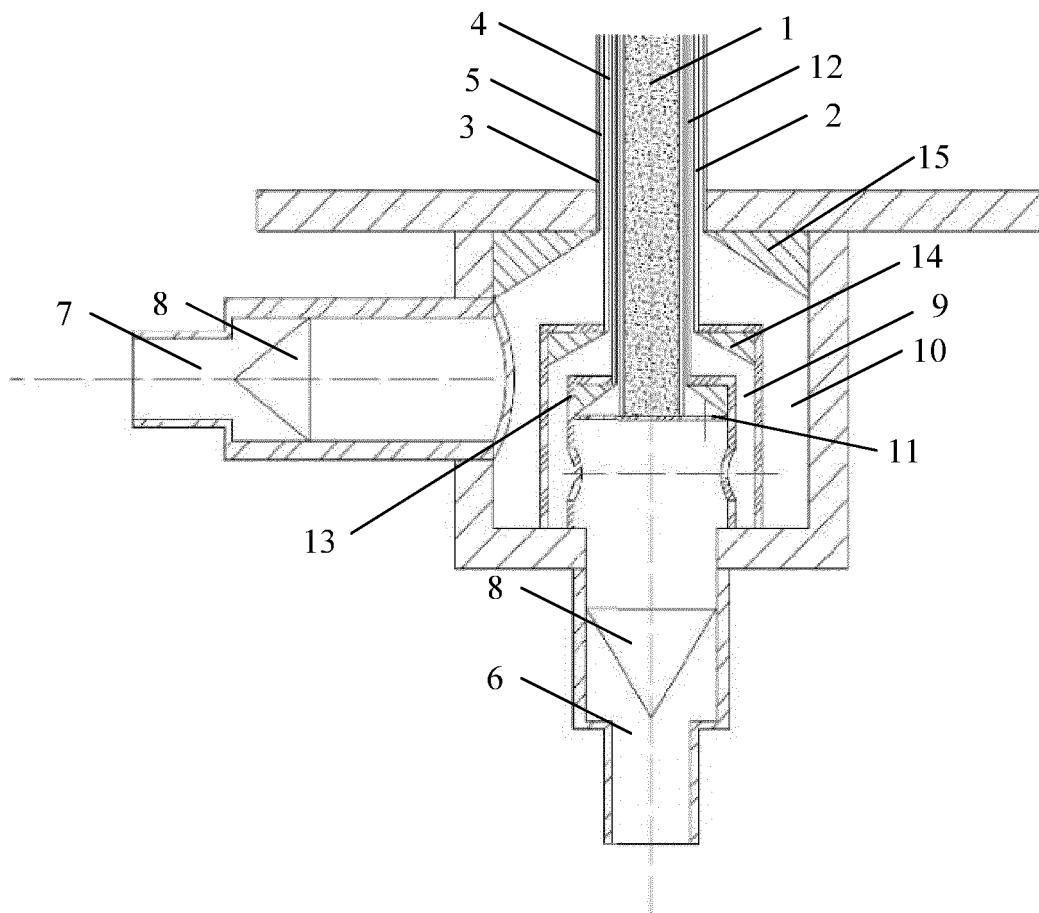


Fig.2

Description

TECHNICAL FIELD

[0001] The application pertains to the field of metallurgical technology, and in particular, to an annular-gap-type gas supply element, and gas supply method.

BACKGROUND ART

[0002] In metallurgical production, according to the needs of production process, a metallurgical furnace needs to be injected various gases (nitrogen, argon, air, etc.) from the bottom and/or a side wall to the metallic bath to optimize the dynamic conditions of the metallurgical furnace metallic bath to achieve the effects of homogeneity composition, promoting reaction, improving efficiency and others, among which the efficient injection of gas is particularly important.

[0003] Slag splashing technology can form a slag splashing layer on the surface of the metallurgical furnace lining by slag splashing, thus protecting furnace lining and prolonging furnace life. With the development of smelting technology, the demand for efficient smelting in metallurgy keeps increasing. Especially, the high intensity gas injection under the condition of thin slag layer or slag-free layer puts forward higher requirements for the gas supply and maintenance process of gas injection components.

[0004] The prior art discloses a multifunctional annular-gap-type gas supply element for steelmaking. By adopting an annular gap gas supply method, problems of small flow adjustment range, easy plugging and easy erosion of capillary, single tube and annular gap tube gas supply methods are solved, and the gas long-life injection under the condition of slag splashing is realized. However, the above annular gap gas supply element has only one control gas path and one gas distribution chamber, which cannot realize separate differential control of inner and outer rings. Under the condition of thin slag layer or slag-free layer, the large flow of the outer ring gas is easy to promote the transition erosion of the refractory material at the contact between the bottom blowing gas supply element and the bottom blowing protective bricks, so it cannot solve the problem of high intensity gas injection under the condition of thin slag layer, slag-free layer or complex process.

SUMMARY OF THE INVENTION

[0005] In view of the above analysis, the present application aims to provide an annular-gap-type gas supply element and gas supply method, so as to solve the problem that high intensity gas injection cannot be achieved under thin slag layer, slag-free layer or complex process condition in the prior art.

[0006] The objects of the present application are mainly realized by the following technical schemes:

An annular-gap-type gas supply element provided by the present disclosure, including a central pipe, an inner sleeve, an outer sleeve, an outer gas space and an inner gas space located in the outer gas space, wherein the central pipe, the inner sleeve and the outer sleeve are arranged in turn; at least one inner annular gap is formed between the central pipe and the inner sleeve, and at least one outer annular gap is formed between the inner sleeve and the outer sleeve, wherein the at least one inner annular gap is connected with the inner gas space, and the at least one outer annular gap is connected with the outer gas space.

[0007] Further, the annular-gap-type gas supply element is suitable for converters, electric furnaces or ladles.

[0008] Further, a gas flow rate of the at least one outer annular gap is less than a gas flow rate of the at least one inner annular gap.

[0009] Further, a gas supply pressure of the at least one outer annular gap is equal to a gas supply pressure of the at least one inner annular gap, and an area of the at least one outer annular gap is smaller than an area of the at least one inner annular gap; Or, the area of the at least one outer annular gap is equal to the area of the at least one inner annular gap, and the gas supply pressure of the at least one outer annular gap is less than the gas supply pressure of the at least one inner annular gap.

[0010] Further, the gap width difference between the at least one inner annular gap and the at least one outer annular gap is less than or equal to 1 mm.

[0011] Further, the gap width of the at least one inner annular gap is 1-2 mm, and the gap width of the at least one outer annular gap is 0.5-1 mm.

[0012] Further, the gap width of the at least one inner annular gap is 1 mm, 1.1 mm, 1.3 mm, 1.5 mm, 1.7 mm, 1.9 mm or 2.0 mm, and the gap width of the at least one outer annular gap 0.5 mm, 0.7 mm, 0.8 mm or 1.0 mm.

[0013] Further, the annular-gap-type gas supply element also includes an inner gas inlet pipe connected with the inner gas space and an outer gas inlet pipe connected with the outer gas space.

[0014] Further, conical screens are set in the inner gas inlet pipe and/or the outer gas inlet pipe.

[0015] Further, tips of the conical screens are oriented opposite to the direction of gas flow.

[0016] Further, each of the conical screens includes a filter screen, a side frame, a shaft frame and springs; the filter screen is set on the side frame to form the side of the conical screen, and the shaft frame is set along the axis of the conical screen; two ends of the side frame are a connecting end close to the tip of the conical screen and a supporting end close to the bottom of the conical screen; two ends of the shaft frame are a pulling end extending out of the inner gas inlet pipe and the outer gas inlet pipe and a supporting end close to the bottom of the conical screen; the supporting end of the side frame is connected with the supporting end of the shaft frame through the springs, and the springs are always in tension; the connecting end of the side frame is rotationally

connected with the shaft frame, and the pulling end of the shaft frame extends out of the inner gas inlet pipe and the outer gas inlet pipe.

[0017] Further, the inner gas space comprises an inner gas chamber and a central overflow plate arranged in the inner gas chamber, and the central overflow plate is provided with central overflow holes; the central pipe is erected on the central overflow plate, and the inner sleeve is erected on the inner gas chamber.

[0018] Further, when there are at least two inner annular gaps, at least one inner transition sleeve is set between the inner sleeve and the central pipe; the inner gas space further includes at least one inner overflow plate between the central overflow plate and the wall of the inner gas chamber; the at least one inner overflow plate is provided with inner overflow holes, and the at least one inner transition sleeve is erected on the at least one inner overflow plate.

[0019] Further, the diameter of the inner overflow holes is larger than the hole diameter of the inner overflow plate.

[0020] Further, the inner gas space also includes inner diversion parts which are arranged at the end of the inner gas chamber near the inner annular gaps, through which the gas is guided to the inner annular gaps.

[0021] Further, guide surfaces of the inner diversion parts are spiral conical.

[0022] Further, the outer gas space includes an outer gas chamber, and the outer sleeve is erected on the outer gas chamber.

[0023] Further, when there are at least two outer annular gaps, at least one outer transition sleeve is set between the outer sleeve and the inner sleeve; the outer gas space further includes at least one outer overflow plate set in the outer gas chamber; the at least one outer overflow plate is provided with outer overflow holes, and the at least one outer transition sleeve is erected on the at least one outer overflow plate.

[0024] Further, the outer gas space also includes outer diversion parts which are arranged at the end of the outer gas chamber near the outer annular gaps, through which the gas is guided to the outer annular gaps.

[0025] Further, guide surfaces of the outer diversion parts are spiral conical.

[0026] Further, the number of the outer annular gap(s) is 1 or 2, and the number of the inner annular gap(s) is 1 or 2.

[0027] The present disclosure further provides a gas supply method of the annular-gap-type gas supply element, using the above-mentioned annular-gap-type gas supply element, and the gas supply method includes the following steps:

inner gas is injected into metallic bath of a metallurgical furnace through an inner gas space and at least one inner annular gap successively;
and/or, outer gas is injected into the metallic bath of the metallurgical furnace through an outer gas space and at least one outer annular gap successively;

wherein the types of the inner gas and the outer gas are the same or different.

[0028] Further, an outer gas flow rate of the at least one outer annular gap is less than an inner gas flow rate of the at least one inner annular gap.

[0029] Further, an outer gas supply pressure of the at least one outer annular gap is equal to an inner gas supply pressure of the at least one inner annular gap, and an area of the at least one outer annular gap is smaller than an area of the at least one inner annular gap; Or, the area of the at least one outer annular gap is equal to the area of the at least one inner annular gap, and the outer gas supply pressure of the at least one outer annular gap is less than the inner gas supply pressure of the at least one inner annular gap.

[0030] Further, the at least one outer annular gap does not supply gas, but only the at least one inner annular gap supplies gas when furnace lining is eroded and the erosion cannot be avoided by reducing outer gas supply flow of the at least one outer annular gap.

[0031] Further, an inner annular gap gas supply channel does not supply gas, but only the at least one outer annular gap supplies gas when the gas supply flow required for smelting is less than 50 m³/h or the gas supply pressure is less than 0.1 MPa.

[0032] Further, when adding molten iron to the metallurgical furnace under the condition that the furnace lining is completely exposed, the inner gas supply pressure of the at least one inner annular gap is the same as the outer gas supply pressure of the at least one outer annular gap, which is conducive to preventing the blocking of molten iron; in the process of molten steel smelting, the inner gas flow rate of the at least one inner annular gap is controlled to be less than the outer gas flow rate of the at least one outer annular gap.

[0033] Further, the inner gas supply pressure of the above at least one inner annular gap is 0.1~3.0MPa; and the outer gas supply pressure of the above at least one outer annular gap is 0.1~3.0MPa.

[0034] The inner gas supply pressure of the above at least one inner annular gap is 0.1 MPa, 0.5 MPa, 0.9 MPa, 1.2 MPa, 1.7 MPa, 1.9 MPa, 2.3 MPa, 2.5 MPa, 2.9 MPa or 3.0 MPa; the outer gas supply pressure of the above at least one outer annular gap is 0.1 MPa, 0.5 MPa, 0.9 MPa, 1.2 MPa, 1.7 MPa, 1.9 MPa, 2.3 MPa, 2.5 MPa, 2.9 MPa or 3.0 MPa.

[0035] Further, the pressure difference between the inner gas supply pressure of the at least one inner annular gap and the outer gas supply pressure of the at least one outer annular gap is ≤ 1.0 MPa.

[0036] Further, the inner gas flow rate of the above at least one inner annular gap is 20~300Nm³ / h, and the outer gas flow rate of the above at least one outer annular gap is 20~300Nm³ / h.

[0037] Further, the inner gas flow rate of the above at least one inner annular gap is 20 Nm³ / h, 55 Nm³ / h, 84 Nm³ / h, 120 Nm³ / h, 170 Nm³ / h, 245 Nm³ / h, 265 Nm³

/ h or 300 Nm³ / h; and the outer gas flow rate of the above at least one outer annular gap is 20 Nm³ / h, 55 Nm³ / h, 84 Nm³ / h, 120 Nm³ / h, 170 Nm³ / h, 245 Nm³ / h, 265 Nm³ / h or 300 Nm³ / h.

[0038] Further, the flow difference between the inner gas flow rate of the at least one inner annular gap and the outer gas flow rate of the at least one outer annular gap is $\leq 200\text{Nm}^3 / \text{h}$.

[0039] Compared with the prior art, the present disclosure can achieve at least one of the following beneficial effects:

a) The annular-gap-type gas supply element provided in the present disclosure is applicable to the gas injection technics of various metallurgical furnaces; by setting different gas spaces and placing the inner gas space in the outer gas space, and using the inner gas space to supply gas to the inner annular gaps, and using the outer gas space to supply gas to the outer annular gaps, during metal smelting process, the inner annular gaps and the outer annular gaps can inject gas into the metallic bath of the metallurgical furnace separately or simultaneously, so that differential control of the inner annular gaps and the outer annular gaps can be realized, and then high intensity gas injection can be realized under the condition of thin slag layer, slag-free layer or the complex process.

b) In the prior art, a single gas space is used to control multiple annular gaps at the same time, and the gas flow rate of each annular gap is automatically distributed, which cannot be controlled separately. The annular-gap-type gas supply element provided in the present disclosure, the inner annular gaps and the outer annular gaps are separately controlled by two gas spaces, which can realize independent control of the gas flow rate injected by the inner annular gaps and the outer annular gaps and has a large adjustment range, so as to be more conducive to the high intensity injection of gas.

c) The annular-gap-type gas supply element provided in the present disclosure, the gas flow rate of the outer annular gaps is less than that of the inner annular gaps, which can properly increase the gas flow rate of the inner annular gaps on the basis of ensuring that the gas flow rate of the outer annular gaps will not be too large, so as to achieve high intensity injection.

[0040] Other features and advantages of the present application will be described in the following description, and some of them will become apparent from the description, or will be understood by implementing the present application. The purpose and other advantages of the present application can be realized and obtained through the structure specially pointed out in the written description and the drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0041] The drawings are only for the purpose of showing specific embodiments, and are not considered to limit the application. In the whole drawing, the same reference symbols represent the same components.

FIG. 1 is the structural diagram of the annular-gap-type gas supply element provided in Embodiment 1 of the disclosure, wherein the number of inner annular gap is 1, and the number of the outer annular gap is 1.

FIG. 2 is another structural diagram of the annular-gap-type gas supply element provided in Embodiment 1 of the disclosure, wherein the number of the inner annular gaps is 2 and the number of outer annular gap is 1.

[0042] Reference numerals are as follows:

1-central pipe; 2-inner sleeve; 3-outer sleeve; 4-inner annular gap; 5-outer annular gap; 6-inner gas inlet pipe; 7-outer gas inlet pipe; 8-conical screen; 9-inner gas chamber; 10-outer gas chamber; 11-central overflow plate; 12-inner transition sleeve; 13-inner overflow plate; 14-inner diversion part; 15-outer diversion part.

DETAILED DESCRIPTION OF THE INVENTION

[0043] The preferred embodiments of the present disclosure will now be described in detail with reference to the accompanying drawings, which form a part hereof, and which together with the embodiments of the present disclosure serve to explain the principles of the present disclosure.

[0044] In the description of the embodiments of the present disclosure, it should be noted that unless otherwise specified and limited, the term "connection" should be understood in a broad sense. For example, it can be a fixed connection, a removable connection, or an integrated connection; it can be a mechanical connection, or an electrical connection; it can be a direct connection, or it can be connected indirectly through an intermediate medium. For those skilled in the art, the specific meaning of the above terms in the present disclosure can be understood according to the specific situation.

[0045] The terms "top", "bottom", "on top of", "below" and "above" used in the specification describe the relative positions of components of the device, such as the relative positions of the top and bottom substrates inside the device. It can be understood that the devices are multifunctional, independent of their orientation in space.

[0046] The normal working surface of the present disclosure can be flat or curved, inclined or horizontal. For the convenience of explanation, in the embodiments of the present disclosure, the working surface is placed on the horizontal plane and used on the horizontal plane, and "high and low" and "up and down" are defined according to the working surface.

Embodiment 1

[0047] The present disclosure provides an annular-gap-type gas supply element, see Figs. 1 to 2, including a central pipe 1, an inner sleeve 2 set on the outer peripheral surface of the central pipe 1, an outer sleeve 3 set on the outer peripheral surface of the inner sleeve 2, an outer gas space and an inner gas space located in the outer gas space. At least one inner annular gap 4 is formed between the central pipe 1 and the inner sleeve 2, and at least one outer annular gap 5 is formed between the inner sleeve 2 and the outer sleeve 3, wherein the inner annular gaps 4 are connected with the inner gas space, and the outer annular gaps 5 are connected with the outer gas space.

[0048] During implementation, the inner gas space and the inner annular gaps 4 form an inner annular gap gas supply channel, and the outer gas space and the outer annular gaps 5 form an outer annular gap gas supply channel. Gas is injected into a metallic bath of a metallurgical furnace through the inner annular gap gas supply channel and the outer annular gap gas supply channel.

[0049] Compared with the prior art, the annular-gap-type gas supply element provided in the present disclosure is applicable to the gas injection technics of various metallurgical furnaces (such as converters, electric furnaces, ladles and other metallurgical vessels). By setting different gas spaces (the inner gas space and the outer gas space) and placing the inner gas space in the outer gas space, and using the inner gas space to supply gas to the inner annular gaps 4, and using the outer gas space to supply gas to the outer annular gaps 5, during metal smelting process, the inner annular gaps 4 and the outer annular gaps 5 can inject gas into the metallic bath of the metallurgical furnace separately or simultaneously, differential control of the inner annular gaps 4 and the outer annular gaps 5 can be realized (for example, same flow rate with different pressure, same pressure with different flow rate, or different pressure and flow rate), and then high intensity gas injection can be realized under the condition of thin slag layer, slag-free layer or the complex process.

[0050] At the same time, it should be noted that in the prior art, a single gas space is used to control multiple annular gaps at the same time, and the gas flow rate of each annular gap is automatically distributed, which cannot be controlled separately. In the annular-gap-type gas supply element provided in the present disclosure, the inner annular gaps 4 and the outer annular gaps 5 are separately controlled by two gas spaces, which can realize independent control of the gas flow rate injected by the inner annular gaps 4 and the outer annular gaps 5 and has a large adjustment range, so as to be more conducive to the high intensity injection of gas.

[0051] From the point of view of protecting furnace lining, the gas flow rate of the outer annular gaps 5 is less than that of the inner annular gaps 4. This is because, in practical application, if the gas flow rate of the outer an-

nular gaps 5 is too large, it is easy to promote the transition erosion of the refractory at the contact between a bottom blowing gas supply element and bottom blowing protective bricks. The gas flow rate of the outer annular gaps 5 is less than that of the inner annular gaps 4, which can properly increase the gas flow rate of the inner annular gaps 4 on the basis of ensuring that the gas flow rate of the outer annular gaps 5 will not be too large, so as to achieve high intensity injection.

[0052] There are two ways to realize that the gas flow rate of the outer annular gaps 5 is less than that of the inner annular gaps 4. Specifically, the gas supply pressure of the outer annular gaps 5 is equal to the gas supply pressure of the inner annular gaps 4, and the areas of the outer annular gaps 5 are smaller than the areas of the inner annular gaps 4; Or, the areas of the outer annular gaps 5 are equal to the areas of the inner annular gaps 4, and the gas supply pressure of the outer annular gaps 5 is less than the gas supply pressure of the inner annular gaps 4.

[0053] Considering that if the gap width difference between the inner annular gaps 4 and the outer annular gaps 5 is too large, it will lead to a large difference in the effect of gas injection. Thus, the gap width difference between the inner annular gaps 4 and the outer annular gaps 5 is less than or equal to 1 mm.

[0054] Specifically, for the gap width of the inner annular gaps 4 and the outer annular gaps 5, for example, the gap width of the inner annular gaps 4 is 1-2 mm (for example, 1 mm, 1.1 mm, 1.3 mm, 1.5 mm, 1.7 mm, 1.9 mm or 2.0 mm), and the gap width of the outer annular gaps 5 is 0.5-1 mm (for example, 0.5 mm, 0.7 mm, 0.8 mm or 1.0 mm). This is because if the gap width of the inner annular gaps 4 and the outer annular gaps 5 is too large, this will result in small gas supply pressure at the same flow rate, which is not conducive to gas injection control, and is easy to cause safety problems and the risk of steel leakage; if the gap width of the inner annular gaps 4 and the outer annular gaps 5 is too large, this is not conducive to the high intensity gas injection, and is easy to cause the blockage of the inner annular gaps 4 and the outer annular gaps 5.

[0055] It can be understood that in order to realize the gas supply of the inner gas space and the outer gas space, the above annular-gap-type gas supply element also includes an inner gas inlet pipe 6 connected with the inner gas space and an outer gas inlet pipe 7 connected with the outer gas space.

[0056] Considering that impurities may exist in the gas, in order to avoid the impact of impurities on metal smelting, conical screens 8 are set in the above-mentioned inner gas inlet pipe 6 and/or outer gas inlet pipe 7. The gas flows through the conical screens 8. The conical screens 8 can filter the impurities in the gas and play the role of purifying the gas, thus reducing the adverse impact of impurities in the gas on metal smelting.

[0057] In order to prevent impurities from blocking filter holes at the tips of the conical screens 8, the tips of the

conical screens 8 are oriented opposite to the direction of gas flow, that is, the tips of the conical screens 8 face the inlet ends of the inner gas inlet pipe 6 and the outer gas inlet pipe 7. In this way, after the impurities pass through the conical screens 8, the impurities can move towards the bottoms of the conical screens 8 under the action of the gas flow, so as to prevent the impurities from blocking the filter holes at the tips of the conical screens 8.

[0058] In order to ensure the filtering performance of the conical screens 8 and facilitate the replacement of the conical screens 8, each of the conical screens 8 includes a filter screen, a side frame, a shaft frame and springs. The filter screen is set on the side frame to form the side of the conical screen 8, and the shaft frame is set along the axis of the conical screen 8. Two ends of the side frame are a connecting end close to the tip of the conical screen 8 and a supporting end close to the bottom of the conical screen 8; two ends of the shaft frame are a pulling end extending out of the inner gas inlet pipe 6 and the outer gas inlet pipe 7 and a supporting end close to the bottom of the conical screen 8. The supporting end of the side frame is connected with the supporting end of the shaft frame through the springs, and the springs are always in tension. The connecting end of the side frame is rotationally connected with the shaft frame, and the pulling end of the shaft frame extends out of the inner gas inlet pipe 6 and the outer gas inlet pipe 7. When the conical screen 8 is seriously blocked and needs to be replaced, pull the pulling end of the shaft frame to make the conical screen 8 move towards the inlet end of the inner gas inlet pipe 6 and the inlet end of the outer gas inlet pipe 7 as a whole, so as to move the support end of the side frame towards or away from the shaft frame. The springs can reduce the diameter of the bottom end of the conical screens 8 by adjusting the tension state, so that the conical screens 8 can be taken out of the inner gas inlet pipe 6 and the outer gas inlet pipe 7 as a whole. In addition, the setting of the springs can ensure that the bottom ends of the filter screens are always in contact with the inner wall of the inner gas inlet pipe 6 and the outer wall of the outer gas inlet pipe 7 to avoid dust leakage and pollution of the inner gas inlet pipe 6 and the outer gas inlet pipe 7.

[0059] For the structure of the inner gas space, specifically, it includes an inner gas chamber 9 and a central overflow plate 11 arranged in the inner gas chamber 9. The central overflow plate 11 is provided with central overflow holes. The central pipe 1 is erected on the central overflow plate 11, and the inner sleeve 2 is erected on the inner gas chamber 9. In this way, the stable installation of the central pipe 1 and the inner sleeve 2 can be realized through the setting of the inner gas chamber 9 and the central overflow plate 11. At the same time, the gas flows through the central overflow holes and is injected into the metallic bath of the metallurgical furnace from the inner annular gaps 4.

[0060] It should be noted that when there are at least two inner annular gaps 4, at least one inner transition

sleeve 12 is set between the inner sleeve 2 and the central pipe 1. In order to achieve the stable installation of the inner transition sleeve 12, the above inner gas space also includes at least one inner overflow plate 13 between the central overflow plate 11 and the wall of the inner gas chamber 9. The inner overflow plate 13 is provided with inner overflow holes, and the inner transition sleeve 12 is erected on the inner overflow plate 13.

[0061] For gas flow, for example, the number of the inner annular gaps 4 is two, namely a first inner annular gap between the central cylinder and the inner transition sleeve 12 and a second inner annular gap between the inner transition sleeve 12 and the inner sleeve 2. The gas flows into the inner gas chamber 9. Part of the gas flows through the central overflow holes and is injected into the metallic bath of the metallurgical furnace from the first inner annular gap, and the other part flows through the inner overflow holes and is injected into the metallic bath of the metallurgical furnace from the second inner annular gap.

[0062] In order to improve the uniformity of the gas injected by multiple inner annular gaps 4, the diameter of the inner overflow holes is larger than the hole diameter of the inner overflow plate 13. This is because, comparing fluid resistance of the gas supply channel, the inner gas chamber 9, the center overflow holes and the first inner annular gap form a first inner annular gap gas supply channel, and the inner gas chamber 9, the inner overflow holes and the second inner annular gap form a second inner annular gap gas supply channel. Obviously, the fluid resistance of the first inner annular gap gas supply channel is smaller than that of the second inner annular gap gas supply channel. With the hole diameter of the inner overflow holes larger than that of the inner overflow plate 13, it can properly reduce the fluid resistance of the second inner annular gap gas supply channel, so as to improve the gas uniformity of multiple inner annular gaps 4.

[0063] In order to guide the gas to the inner annular gaps 4 smoothly, the inner gas space also includes inner diversion parts 14 which are arranged at the end of the inner gas chamber 9 near the inner annular gaps 4. The inner diversion parts 14 can guide the gas to the inner annular gaps 4.

[0064] For the structure of the inner diversion parts 14, specifically, the guide surfaces of the inner diversion parts 14 are spiral conical, and the so-called guide surfaces refer to the surfaces where the inner diversion parts 14 contact with the gas. The gas can be converged through the spiral conical guide surfaces, so that the gas gradually converges to the inner annular gaps 4 and enters the inner annular gaps 4. At the same time, the spiral conical guide surfaces are used to make the gas form a rotating airflow during the flow process. The rotating airflow flows in the inner annular gaps 4, which can reduce the fluid resistance, thus increasing the ventilation effect of the inner annular gaps 4 and avoiding the blockage of the inner annular gaps 4.

[0065] Similarly, for the structure of the outer gas space, specifically, it includes an outer gas chamber 10, and the outer sleeve 3 is erected on the outer gas chamber 10. In this way, the stable installation of the outer sleeve 3 can be realized through the setting of the outer gas chamber 10.

[0066] It should be noted that when there are at least two outer annular gaps 5, at least one outer transition sleeve (not shown in the figure) is set between the outer sleeve 3 and the inner sleeve 2. In order to achieve the stable installation of the outer transition sleeve, the above outer gas space also includes at least one outer overflow plate (not shown in the figure) set in the outer gas chamber 10. The outer overflow plate is provided with outer overflow holes, and the outer transition sleeve is erected on the outer overflow plate.

[0067] For gas flow, for example, the number of the outer annular gaps 5 is two, namely a first outer annular gap between the outer transition sleeve and the outer sleeve 3 and a second outer annular gap between the inner sleeve 2 and the outer transition sleeve. The gas flows into the outer gas chamber 10. Part of the gas is injected into the metallic bath of the metallurgical furnace from the first outer annular gap, and the other part is injected into the metallic bath of the metallurgical furnace from the second outer annular gap through the outer overflow holes.

[0068] In order to guide the gas to the outer annular gaps 5 smoothly, the outer gas space also includes outer diversion parts 15 which are arranged at the end of the outer gas chamber 10 near the outer annular gaps 5. The outer diversion parts 15 can guide the gas to the outer annular gaps 5.

[0069] For the structure of the outer diversion parts 15, specifically, the guide surfaces of the outer diversion parts 15 are spiral conical, and the so-called guide surfaces refer to the surfaces where the outer diversion parts 15 contact with the gas. The spiral conical guide surfaces can converge the gas and make the gas gradually converge to the outer annular gaps 5 and enter the outer annular gaps 5. At the same time, the spiral conical guide surfaces are used to make the gas form a rotating airflow during the flow process. The rotating airflow flows in the outer annular gaps 5, which can reduce the fluid resistance, thus increasing the ventilation effect of the outer annular gaps 5 and avoiding the blockage of the outer annular gaps 5.

[0070] For the number of outer annular gaps 5 and inner annular gaps 4, for example, the number of the outer annular gap(s) 5 is 1 or 2, and the number of the inner annular gap(s) 4 is 1 or 2. This is because the gap width of the inner annular gaps 4 and the outer annular gaps 5 are related to the flow and injection safety. Under the condition that the gap width of the inner annular gaps 4 and the outer annular gaps and the gas supply pressure are fixed, the number of the inner annular gap(s) 4 and the outer annular gap(s) 5 is 1 to 2, which can not only effectively simplify the internal structure of the above-

mentioned annular-gap-type gas supply element, but also improve the injection gas flow rate and flow rate adjustment range.

5 Embodiment 2

[0071] This embodiment provides a gas supply method of the annular-gap-type gas supply element, including the following steps:

Inner gas is injected into a metallic bath of a metallurgical furnace through the inner gas space and the inner annular gaps successively;

And/or, outer gas is injected into the metallic bath of the metallurgical furnace through the outer gas space and the outer annular gaps successively;

The types of the inner gas and the outer gas are the same or different.

[0072] Compared with the prior art, the beneficial effects of the gas supply method of the annular-gap-type gas supply element provided in this embodiment is basically the same as that of the annular-gap-type gas supply element provided in Embodiment 1, which will not be described in detail here.

[0073] From the point of view of protecting furnace lining, in the above gas supply method, the outer gas flow rate of the outer annular gaps is less than the inner gas flow rate of the inner annular gaps. This is because, in practical application, if the outer gas flow rate of the outer annular gaps is too large, it is easy to promote the transition erosion of the refractory at the contact between a bottom blowing gas supply element and bottom blowing protective bricks. The outer gas flow rate of the outer annular gaps is less than the inner gas flow rate of the inner annular gaps, which can properly increase the internal gas flow rate of the inner annular gaps on the basis of ensuring that the outer gas flow rate of the outer annular gaps will not be too large, so as to achieve high intensity injection.

[0074] There are two ways to realize that the outer gas flow rate of the outer annular gaps is less than the inner gas flow rate of the inner annular gaps. Specifically, the outer gas supply pressure of the outer annular gaps is equal to the inner gas supply pressure of the inner annular gaps, and the areas of the outer annular gaps are smaller than the areas of the inner annular gaps; Or, the areas of the outer annular gaps are equal to the areas of the inner annular gap, and the inner gas supply pressure of the outer annular gaps is less than the inner gas supply pressure of the inner annular gaps.

[0075] It should be noted that when the furnace lining is eroded and the erosion cannot be avoided by reducing the outer gas supply flow rate of the outer annular gaps, the outer annular gaps do not supply gas, but only the inner annular gaps supply gas.

[0076] When the gas supply flow rate required for smelting is less than 50 m³/h or the gas supply pressure

is less than 0.1 MPa, the simultaneous gas supply of the inner and outer annular gaps will cause the inner gas supply pressure and the outer gas supply pressure to be too small, and the molten steel will flow back into the inner and outer annular gaps, causing plugging of the inner and outer annular gaps. Therefore, the inner annular gap gas supply channel will not supply gas, but only the outer annular gaps supply gas. In addition, adopting the mode of no gas supply in the inner annular gap gas supply channel and only the outer annular gaps supplying gas is equivalent to expanding the area of no gas supply in the center of the above gas supply unit, which is equivalent to increasing the area of the central cylinder, and can also avoid water sag. It should be noted that the water sag phenomenon refers to the erosion of the gas outlet ends of the inner annular gaps and the gas outlet ends of the outer annular gaps caused by the rising of bubbles and the falling of liquid with the same volume as bubbles in the process of bottom blowing gas supply.

[0077] For example, when adding molten iron to the metallurgical furnace under the condition that the furnace lining is completely exposed, the inner gas supply pressure of the inner annular gaps is controlled to be the same as the outer gas supply pressure of the outer annular gaps, for example, greater than 0.3 MPa, which is conducive to preventing the blocking of molten iron. In the process of molten steel smelting, the inner gas flow rate of the inner annular gaps is controlled to be less than the outer gas flow rate of the outer annular gaps, which is beneficial to reduce the erosion of the refractory material contacting with the bottom blown protective bricks.

[0078] As an example, the inner gas supply pressure of the above inner annular gaps is 0.1~3.0MPa (e.g. 0.1 MPa, 0.5 MPa, 0.9 MPa, 1.2 MPa, 1.7 MPa, 1.9 MPa, 2.3 MPa, 2.5 MPa, 2.9 MPa or 3.0 MPa), and the outer gas supply pressure of the above outer annular gaps is 0.1~3.0MPa (e.g. 0.1 MPa, 0.5 MPa, 0.9 MPa, 1.2 MPa, 1.7 MPa, 1.9 MPa, 2.3 MPa, 2.5 MPa, 2.9 MPa or 3.0 MPa), and the pressure difference between the inner gas supply pressure of the inner annular gaps and the outer gas supply pressure of the outer annular gaps is ≤ 1.0 MPa. The inner gas flow rate of the above inner annular gaps is 20~300Nm³ / h (e.g. 20 Nm³ / h, 55 Nm³ / h, 84 Nm³ / h, 120 Nm³ / h, 170 Nm³ / h, 245 Nm³ / h, 265 Nm³ / h or 300 Nm³ / h), and the outer gas flow rate of the above outer annular gaps is 20~300Nm³ / h (e.g. 20 Nm³ / h, 55 Nm³ / h, 84 Nm³ / h, 120 Nm³ / h, 170 Nm³ / h, 245 Nm³ / h, 265 Nm³ / h or 300 Nm³ / h), and the flow rate difference between the inner gas flow rate of the inner annular gaps and the outer gas flow rate of the outer annular gaps is ≤ 200 Nm³ / h.

[0079] The above is only preferred embodiments of the present application, but the scope of the present application is not limited thereto, and any modification or substitution that can be easily conceived by those skilled in the art within the spirit and principle of the present disclosure shall be included in the protection scope of the present disclosure.

Claims

1. An annular-gap-type gas supply element, **characterized in that** it comprises a central pipe, an inner sleeve, an outer sleeve, an outer gas space and an inner gas space located in the outer gas space, wherein the central pipe, the inner sleeve and the outer sleeve are arranged in turn;
at least one inner annular gap is formed between the central pipe and the inner sleeve, and at least one outer annular gap is formed between the inner sleeve and the outer sleeve, wherein the at least one inner annular gap is connected with the inner gas space, and the at least one outer annular gap is connected with the outer gas space.
2. The annular-gap-type gas supply element according to claim 1, wherein gas flow rate of the at least one outer annular gap is less than gas flow rate of the at least one inner annular gap.
3. The annular-gap-type gas supply element according to claim 1, wherein it further comprises an inner gas inlet pipe connected with the inner gas space and an outer gas inlet pipe connected with the outer gas space.
4. The annular-gap-type gas supply element according to claim 3, wherein conical screens are set in the inner gas inlet pipe and/or the outer gas inlet pipe.
5. The annular-gap-type gas supply element according to claim 4, wherein tips of the conical screens are oriented opposite to the direction of gas flow.
6. The annular-gap-type gas supply element according to any one of claims 1-5, wherein the inner gas space comprises an inner gas chamber and a central overflow plate arranged in the inner gas chamber, and the central overflow plate is provided with central overflow holes; the central pipe is erected on the central overflow plate, and the inner sleeve is erected on the inner gas chamber;
and/or, the outer gas space comprises an outer gas chamber, and the outer sleeve is erected on the outer gas chamber.
7. The annular-gap-type gas supply element according to claim 6, wherein at least one inner transition sleeve is set between the inner sleeve and the central pipe;

the inner gas space further includes at least one inner overflow plate between the central overflow plate and the wall of the inner gas chamber; the at least one inner overflow plate is provided with inner overflow holes, and the at least one inner transition sleeve is erected on the at least one inner overflow plate.

8. The annular-gap-type gas supply element according to claim 6, wherein at least one outer transition sleeve is set between the outer sleeve and the inner sleeve;
the outer gas space further includes at least one outer overflow plate set in the outer gas chamber; the at least one outer overflow plate is provided with outer overflow holes, and the at least one outer transition sleeve is erected on the at least one outer overflow plate. 5 10
9. A gas supply method of the annular-gap-type gas supply element, **characterized in that** it comprises the following steps: 15
- inner gas is injected into metallic bath of a metallurgical furnace through an inner gas space and at least one inner annular gap successively; and/or, outer gas is injected into the metallic bath of the metallurgical furnace through an outer gas space and at least one outer annular gap successively; 20
- wherein the types of the inner gas and the outer gas are the same or different. 25
10. The gas supply method of the annular-gap-type gas supply element according to claim 9, wherein the at least one outer annular gap does not supply gas, but only the at least one inner annular gap supplies gas when furnace lining is eroded and the erosion cannot be avoided by reducing outer gas supply flow rate of the at least one outer annular gap; 30
- or, an inner annular gap gas supply channel does not supply gas, but only the at least one outer annular gap supplies gas when the gas supply flow rate required for smelting is less than 50 m³/h or the gas supply pressure is less than 0.1 MPa; 35
- or, when adding molten iron to the metallurgical furnace under the condition that the furnace lining is completely exposed, the inner gas supply pressure of the at least one inner annular gap is the same as the outer gas supply pressure of the at least one outer annular gap; 40 45
- or, in the process of molten steel smelting, the inner gas flow rate of the at least one inner annular gap is less than the outer gas flow rate of the at least one outer annular gap. 50

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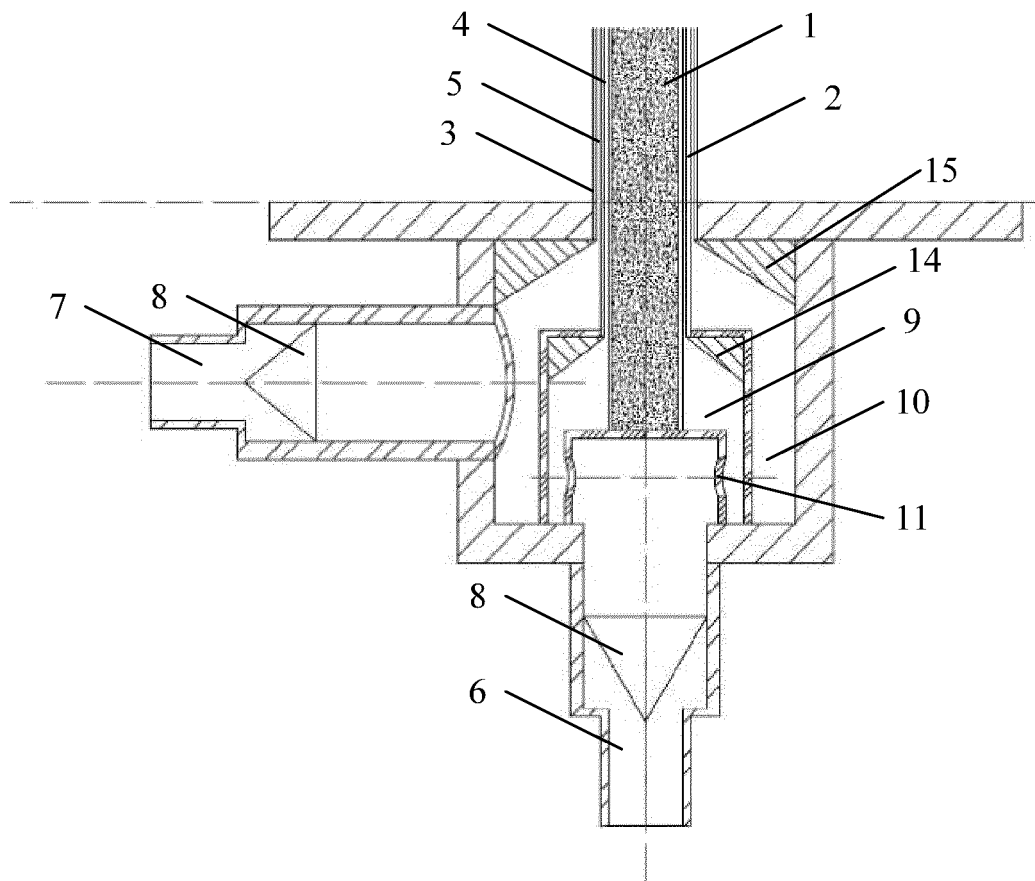


Fig.1

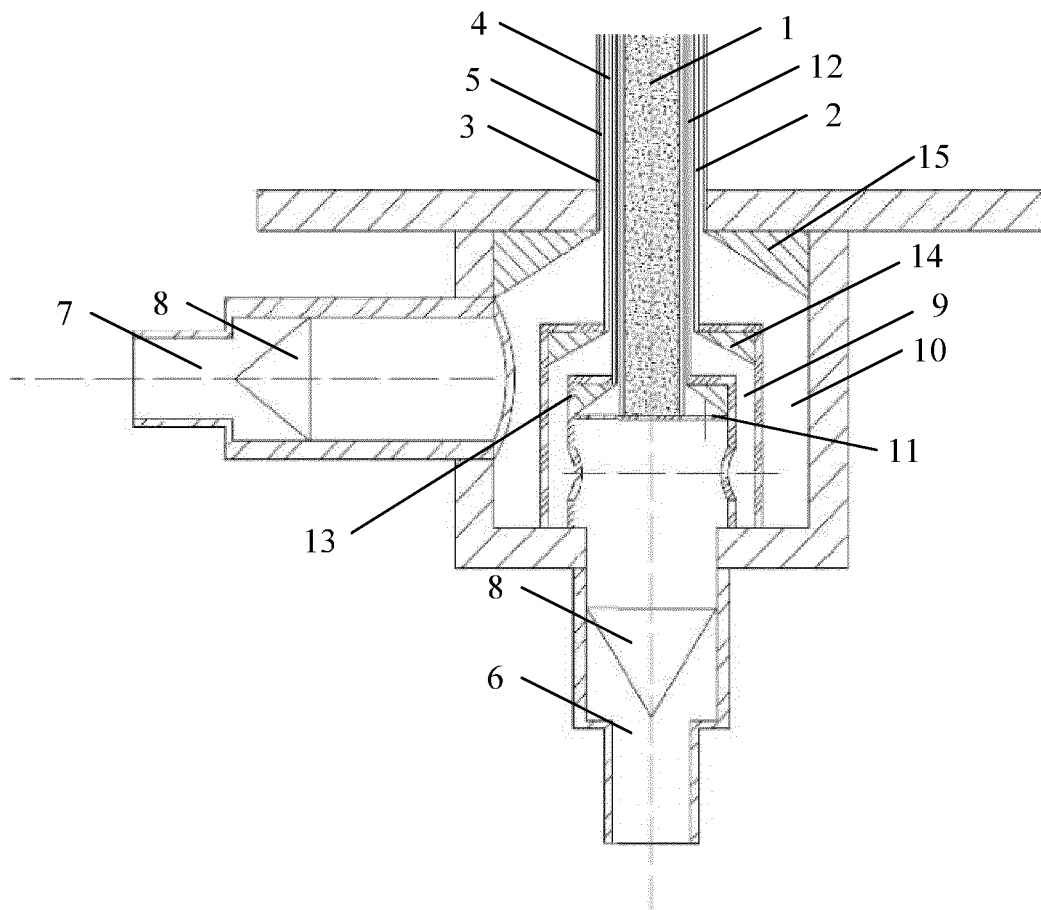


Fig.2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2021/106074

A. CLASSIFICATION OF SUBJECT MATTER

F27D 7/02(2006.01)i; F27D 19/00(2006.01)i; C21C 5/48(2006.01)i; C21C 5/52(2006.01)i; C21C 7/072(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F27D; C21C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, CNTXT, CNKI, DWPI, SIPOABS, VEN, EPTXT, USTXT, WOTXT, TWTXT: 钢铁研究总院, 杨利彬, 王杰, 杨勇, 赵进宜, 汪成义, 蔡伟, 供气, 环缝, 气室, 气腔, 管, 套管, 外, 内, tuyere?, air, gas, feed+, supply+, blow+, inject+, jetting, tube?, pipe?, sleeve???, bushing, annular, ring, circular, smelt+, melt+, molten, furnace

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 112212700 A (CENTRAL IRON & STEEL RESEARCH INSTITUTE) 12 January 2021 (2021-01-12) claims 1-10, and figures 1 and 2	1-10
PX	TW M608963 U (CENTRAL IRON & STEEL RESEARCH INSTITUTE) 11 March 2021 (2021-03-11) claims 1-8, and figures 1-2	1-10
X	CN 110172542 A (MAANSHAN IRON & STEEL CO., LTD.) 27 August 2019 (2019-08-27) description, paragraphs 23-26, and figures 1-4	9-10
Y	CN 110172542 A (MAANSHAN IRON & STEEL CO., LTD.) 27 August 2019 (2019-08-27) description, paragraphs 23-26, and figures 1-4	1-8
Y	CN 201801544 U (JINAN LUDONG REFRACTORY CO., LTD.) 20 April 2011 (2011-04-20) description, paragraphs 15-16, and figures 1-3	1-8
Y	CN 87203177 U (NORTH-EAST POLYTECH. COLLEGE) 06 January 1988 (1988-01-06) description, page 3, last paragraph, figure 1	1-8

☒ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

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“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

30 July 2021

Date of mailing of the international search report

01 September 2021

Name and mailing address of the ISA/CN

China National Intellectual Property Administration (ISA/
CN)
No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing
100088
China

Authorized officer

Facsimile No. (86-10)62019451

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/106074

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2006283065 A (JFE STEEL K. K.) 19 October 2006 (2006-10-19) entire document	1-10
A	CN 2461934 Y (GEN INST OF IRON & STEEL) 28 November 2001 (2001-11-28) entire document	1-10

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/106074

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CN	87203177	U	06 January 1988	None		
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